Workshop on Greenhouse Gas Emission Mitigation through Changing Urban Lifestyles toward Water and Energy Saving in Da Nang

International Experience on Greenhouse Gas Emission Reduction from Water and Energy End-Use Saving - Good Practices and Lessons Learned

Pham Ngoc Bao, Ph.D
Senior Water and Sanitation Specialist
Institute for Global Environmental Strategies (IGES)
Email: ngoc-bao@iges.or.jp

Da Nang, 10th October 2017

ADDRESSING THE CRITICAL QUESTIONS BEFORE ACTIONS

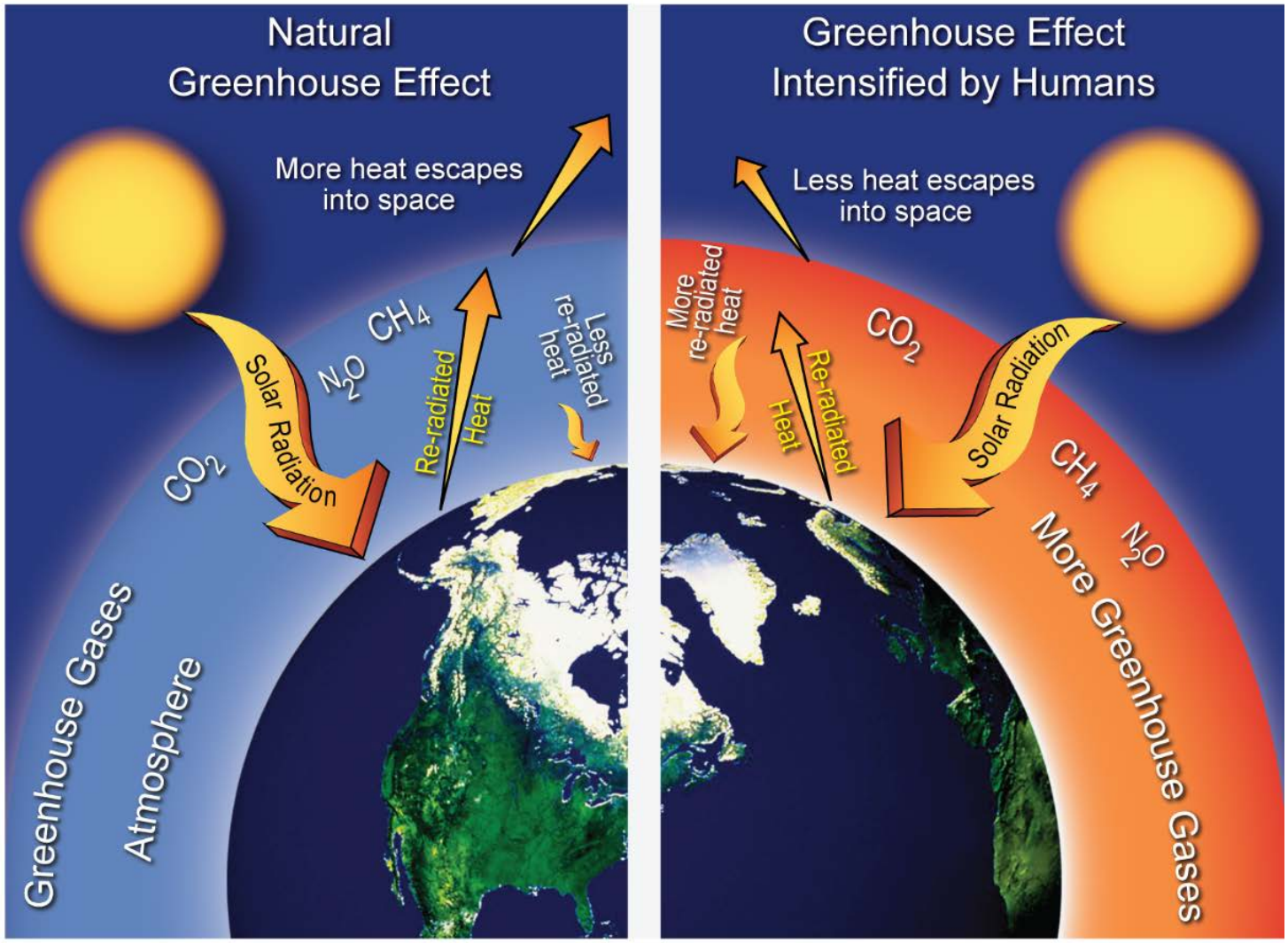
- ✓ Why GHG emission reduction is necessary?
- ✓ Is there any interlinkage between lifestyles CHANGE, water-energy saving practices, and GHG emission reduction?

1. Must we change?

2. Can we change?

3. Will we change?

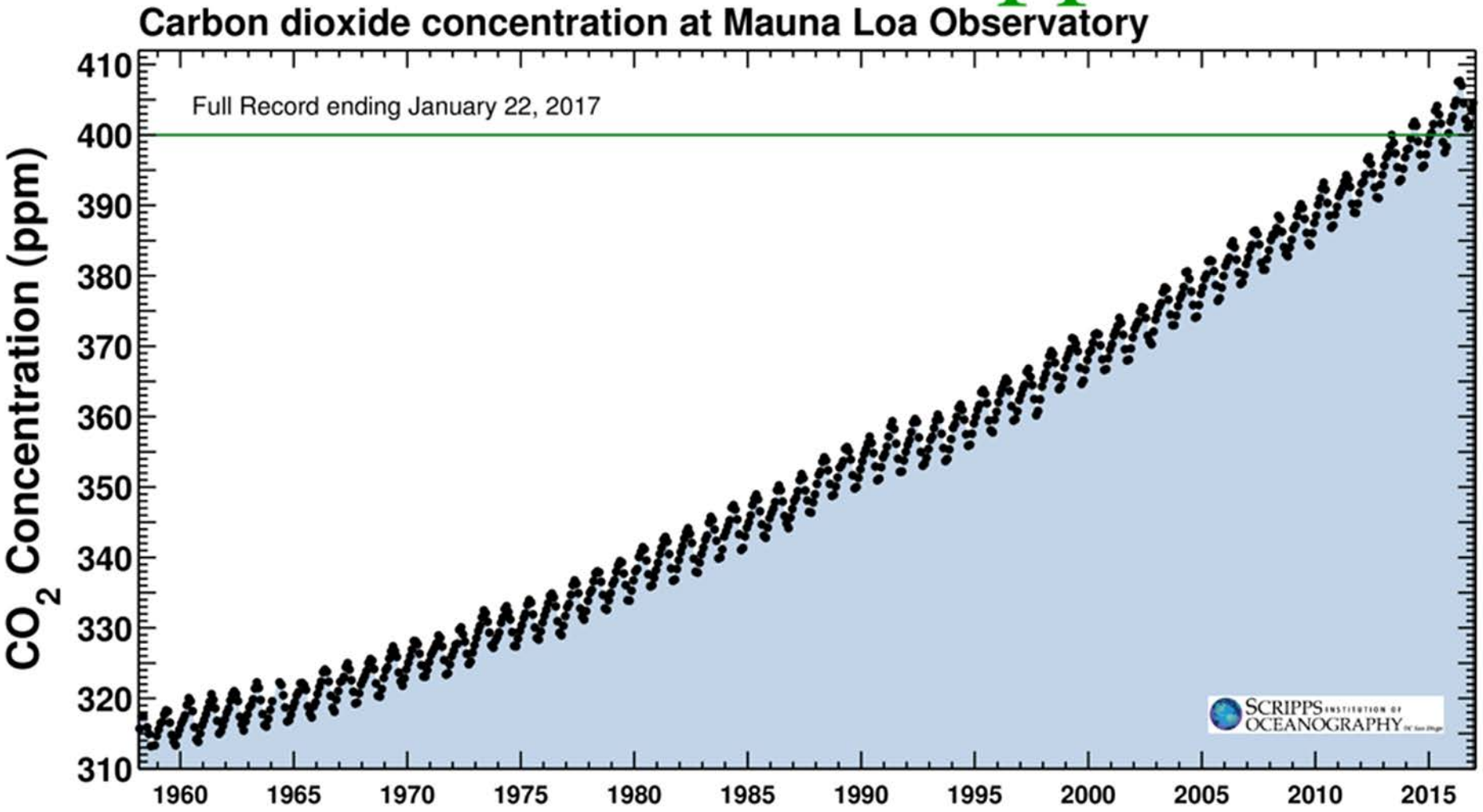
Why GHG emission reduction is necessary?



(Source: Elder, 2013)

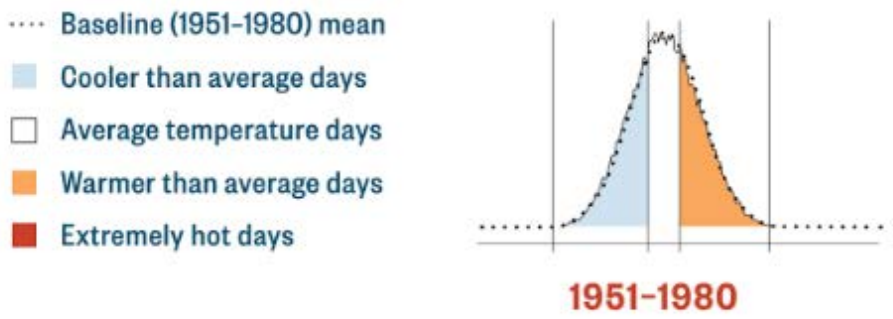
Latest CO_2 reading
January 22, 2017

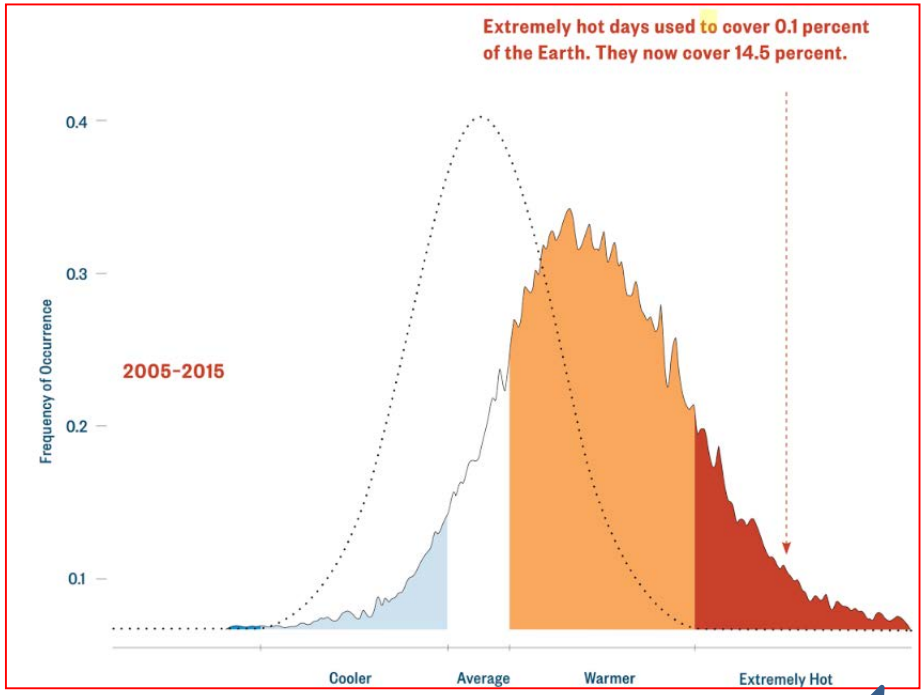
406.58 ppm

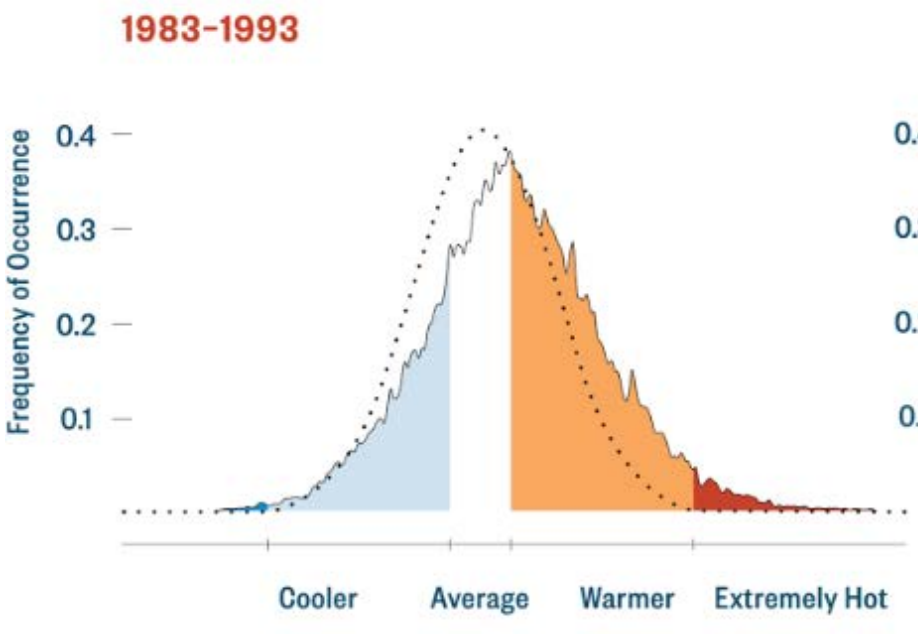


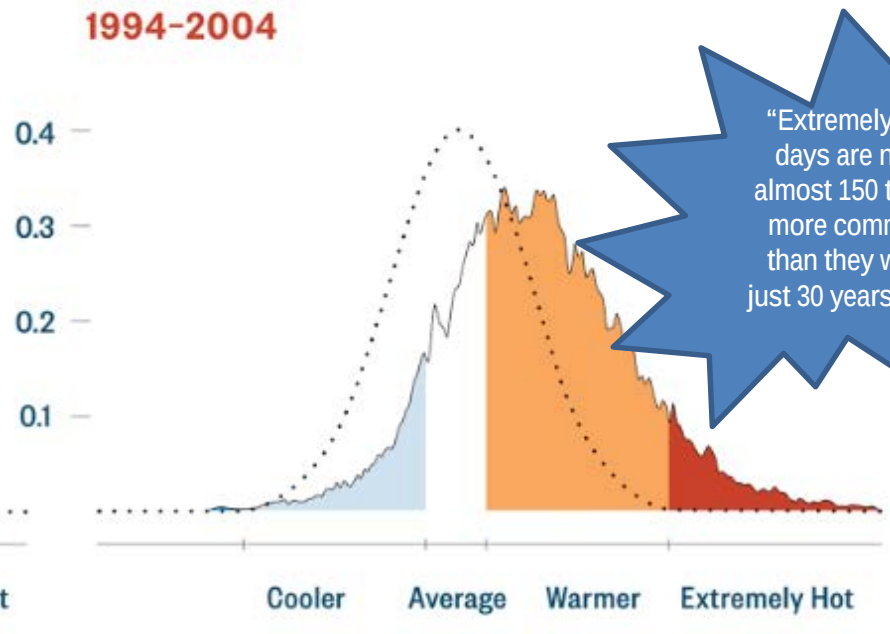
"Concentrations of carbon dioxide in Earth's atmosphere have risen rapidly since measurements began nearly 60 years ago, climbing from 316 parts per million (ppm) in 1958 to more than 400 ppm today" (Scripps Institution of Oceanography, 2017)

SHIFT IN SUMMER TEMPERATURES, 1951-2015







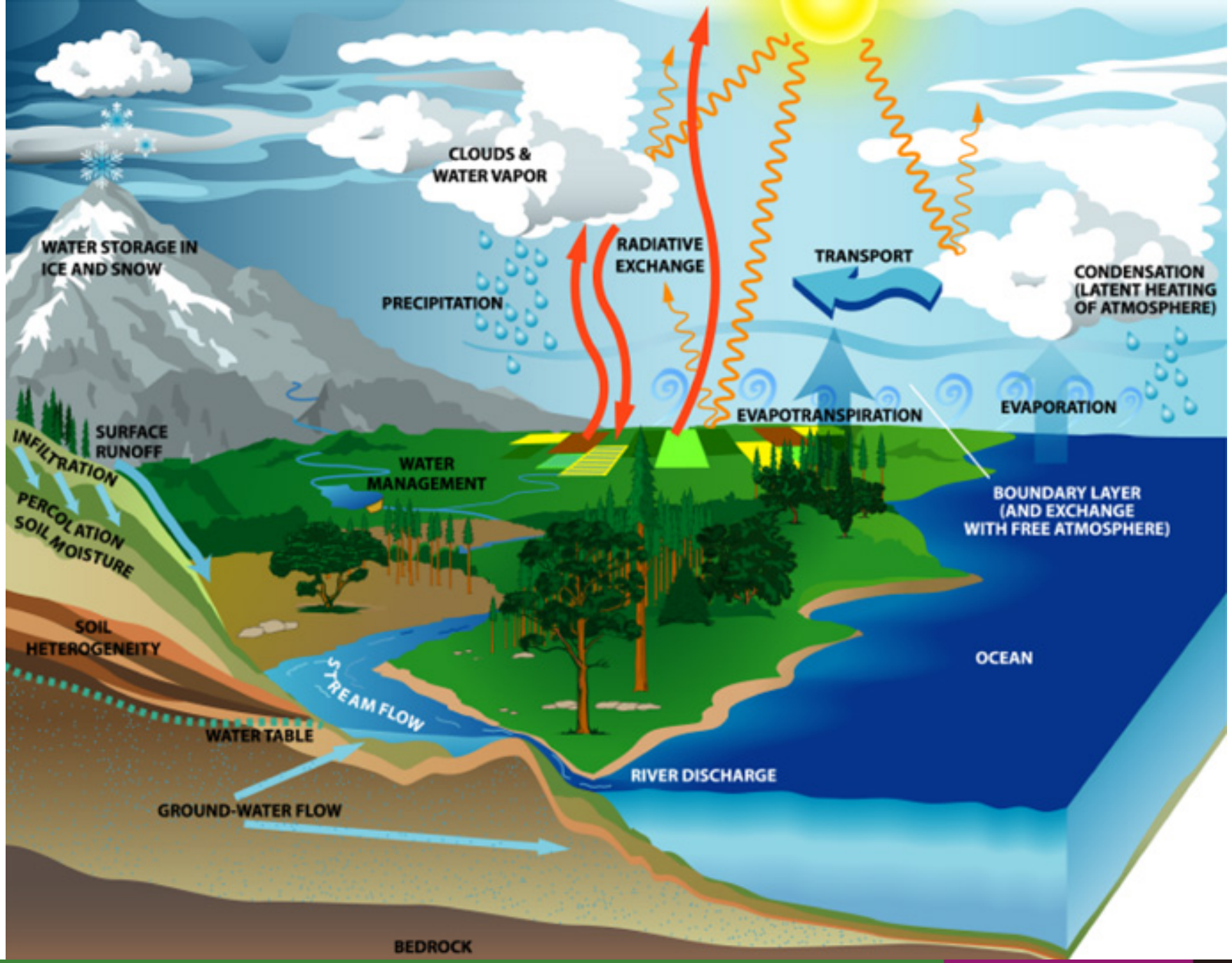


"Extremely hot days are now almost 150 times more common than they were just 30 years ago"

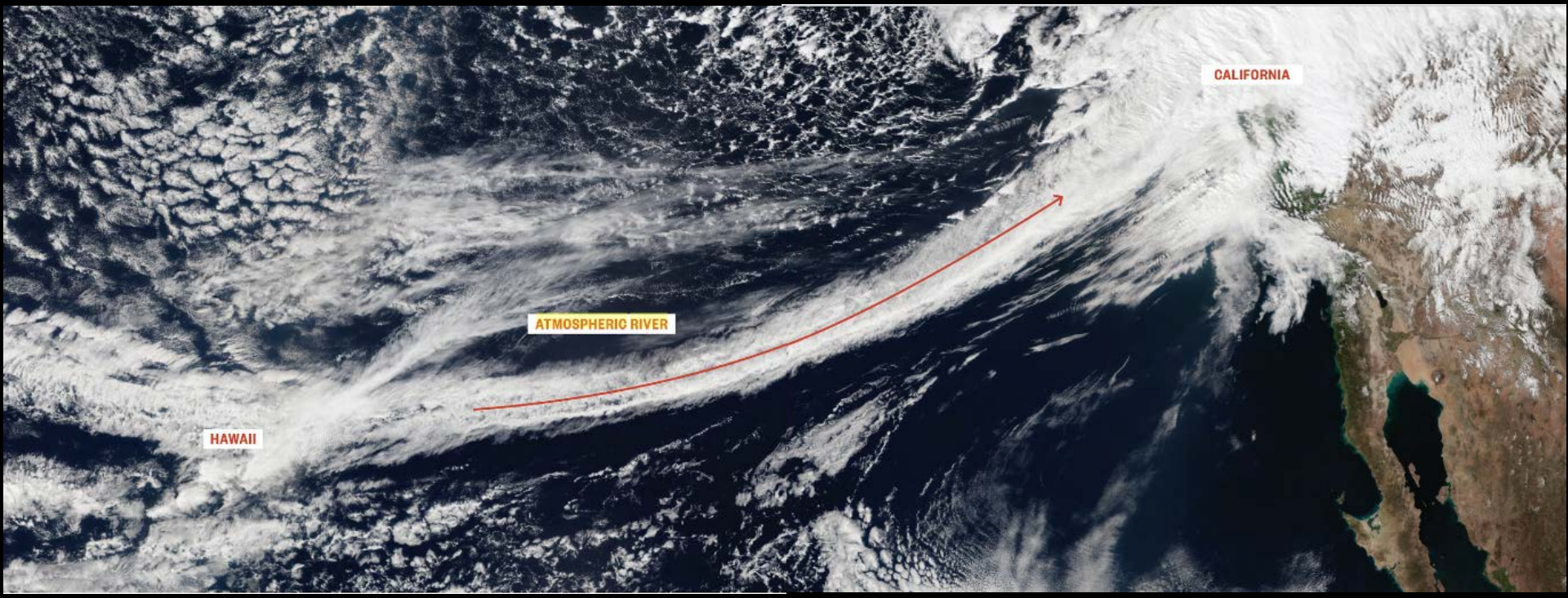
(Source: NASA's HANSEN, ET AL., 2016; Al Gore, 2017)

“A Farewell to Ice”

(Source: The Guardian, 2016)



(Source: Ward and Robinson, 2000; Chahine, 1992)



An atmospheric river seen from the NOAA/NASA Suomi NPP satellite, Pacific Ocean, 2017

(Source: Al Gore, 2017)

(Source: Al Gore, 2017)

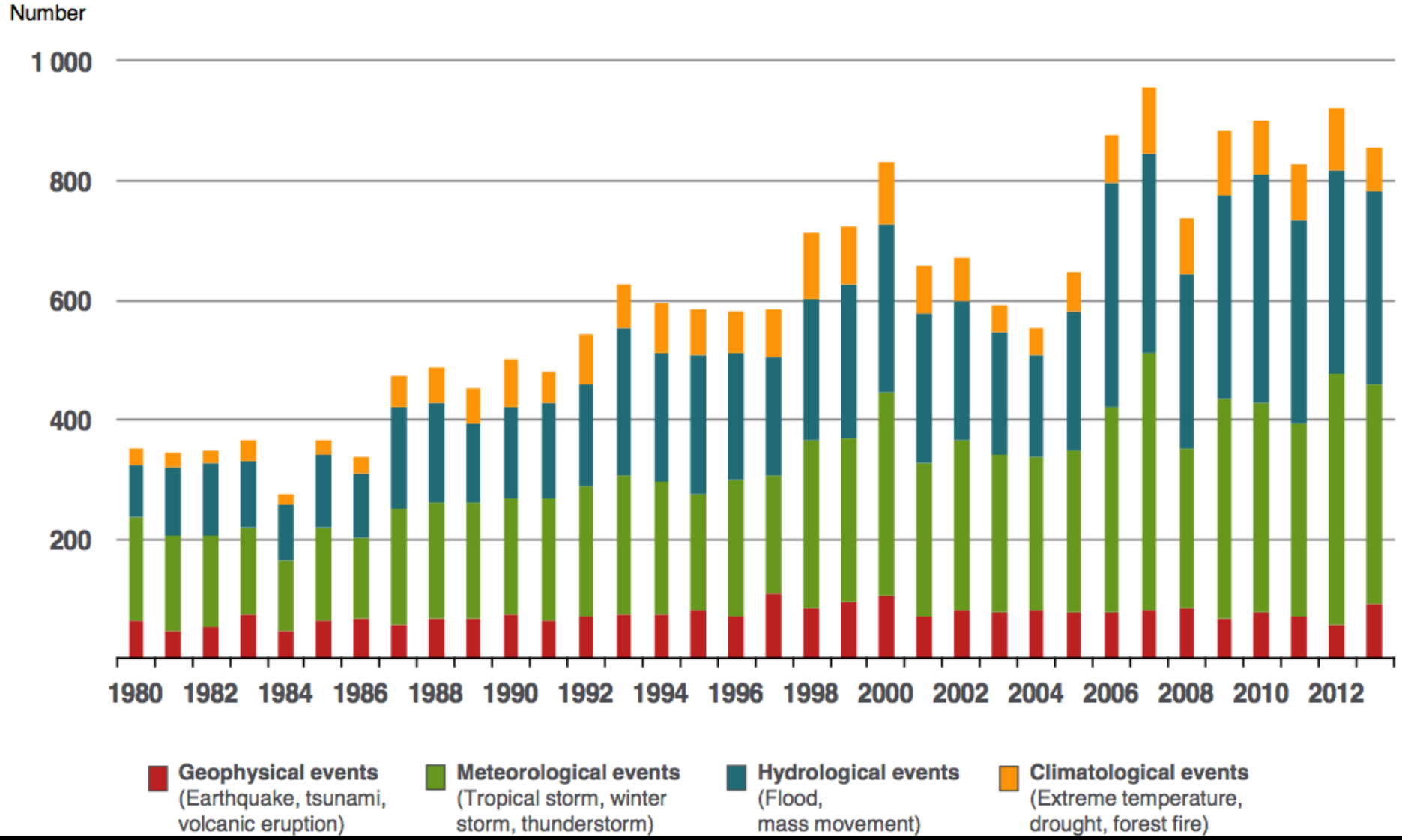
Historical drought in the Mekong delta of Vietnam in 2016

(Source: Enternews, 2016)

Heavy rain caused severe flooding in Hanoi in 2016

(Source: Doisongphapluat.com, 2016)

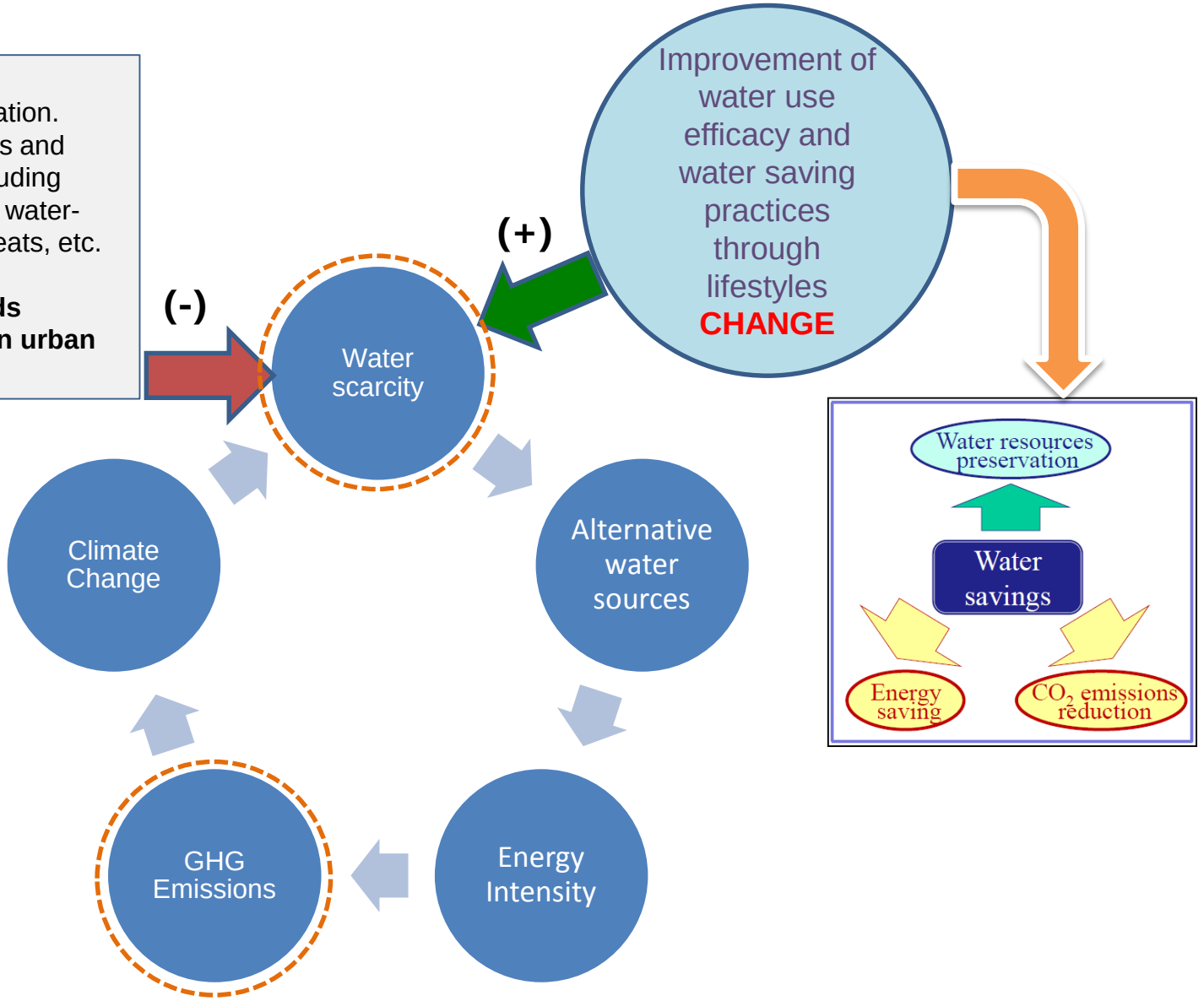
“Prediction of our future can no longer be based on our past”



(Source: Roger, 2017)

- Rapid population growth
- Urbanization & industrialization.
- Changing in urban lifestyles and consumption patterns, including shifting diets toward highly water-intensive foods such as meats, etc.

→ **Increasing water demands**
→ **Placing a huge burden on urban water infrastructures**



Interlinkages among urban lifestyle CHANGES, water-energy saving, and GHG emission reduction

Energy use intensity based on various water supply sources/stages in different regions.

Water supply sources/stages	Region	Purpose	Energy use	References
Groundwater extraction	California, USA	Groundwater pumping	0.14–0.69 kW h/m^3	Plappally and Lienhard (2012)
	Central Arizona, USA	Lifting groundwater	3.3 kW h/m^3	Perrone et al. (2011)
	USA	Whole water supply system	1.02 kW h/m^3	Sattenspiel and Wilson (2009)
	USA	Groundwater pumping	0.18–0.49 kW h/m^3	EPRI (2002)
	Chino Basin, Southern California	Groundwater pumping	0.79 kW h/m^3	Wilkinson, 2005
	Australia	Groundwater pumping	0.48–0.53 kW h/m^3	Rocheta and Pearson (2011)
Surface water extraction/pumping	Western China	Pumping of water over 450 km pipeline	7.1×10^9 kW h/annum[a]	Marsh, 2008
	Ontario, Canada	Pumping	5.55×10^9 kW h/annum[a]	Maas, 2010
	Sydney, Australia	Water supply pumping for 2006/07	0.92 kW h/m^3	Kenway et al., 2008
Water distribution/conveyance	Northern California		0.04 kW h/m^3	CEC (2005)
	Southern California		2.4 kW h/m^3	CEC (2005)
Water treatment	Australia	Raw water treatment	0.1–0.6 kW h/m^3	Marsh, 2008
	USA	Raw water treatment	0.027–4.32 kW h/m^3	Sattenspiel and Wilson (2009)
	Northern and Southern California, USA	Raw water treatment	0.027 kW h/m^3	CEC (2005)
	Sydney, Australia	Raw water treatment for 2006/07	0.1 kW h/m^3	Kenway et al. (2008)
End Use	Ontario, Canada	Residential heating	24.6 kW hkW h/m^3	Maas (2010)
	USA	US residential end use	208.38 kW h/m^3	Sattenspiel and Wilson (2009)
	California	For the year 2006/07	13,528 kW h/annum[a]	CEC (2005)
	Australia	Residential end use	12.77×10^9 kW h/annum[a]	Kenway et al. (2008)
Wastewater treatment (WWT)	Australia	Advanced WWT	0.8–1.5 kW h/m^3	Marsh (2008)
	California	WWT energy use in 2001	2012×10^6 kW h/annum[a]	CEC (2005)
	Sydney, Australia	WWT energy use in 2006/07	0.38 kW h/m^3	Kenway et al. (2008)
Desalination	General	Seawater desalination	3–5 kW h/m^3	Marsh (2008)
	General	Seawater desalination	3.73 kW h/m^3	Sattenspiel and Wilson (2009)
	Australia	Seawater desalination	4 kW h/m^3	Rocheta and Pearson (2011)
Recycled water	Central Arizona, USA	Recycling wastewater	3.6 kW h/m^3	Perrone et al. (2011)
	General	Recycling wastewater	0.3 kW h/m^3	Sattenspiel and Wilson (2009)

(Source: (Nair et al. 2014)

ADDRESSING THE CRITICAL QUESTIONS BEFORE ACTIONS

- ✓ Why GHG emission reduction is necessary?
- ✓ Is there any interlinkage between lifestyles CHANGE, water-energy saving practices, and GHG emission reduction?

1. Must we change? "YES"

2. Can we change?

3. Will we change?

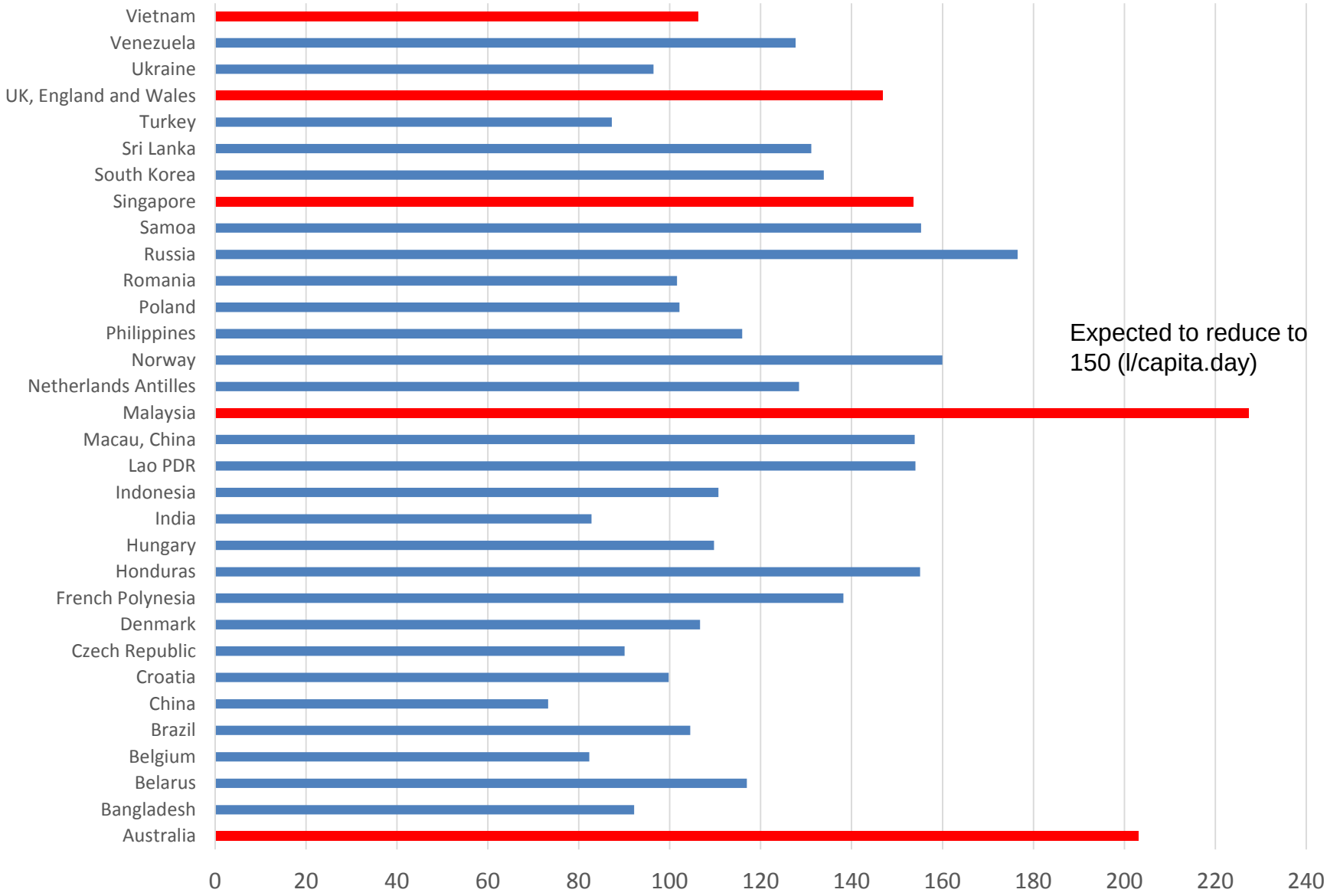
1a	Australia	Water Efficiency Labelling Scheme (indoor use)	7	Malaysia	Guidelines Voluntary WEPLS
1b	Australia	Smart Approved Watermark (outdoor use)	8	New Zealand	Water Efficiency Labelling Scheme
2	Canada	WaterSense	9	Portugal	National Plan for Efficient Water Use
3	China	Water Conservation Certification	10	Singapore	Water Efficiency Labelling Scheme
4	Europe	European Water Label	11	UAE	Emirates Authority for Standardisation and Metrology
5	Hong Kong	Voluntary Water Efficiency Labelling	12	United Kingdom	ECA Water Technology List
6	India	Water Efficient Products-India	13	United States	WaterSense

Water Efficiency Schemes recognized by World Plumbing Council

Water Efficiency Schemes recognized by World Plumbing Council

No.	Country/Area	Scheme	Scope
1a	Australia	Water Efficiency Labelling Scheme (indoor use)	Mandatory
1b	Australia	Smart Approved Watermark (outdoor use)	Voluntary
2	Canada	WaterSense	Voluntary
3	China	Water Conservation Certification	Voluntary
4	Europe	European Water Label	Voluntary
5	Hong Kong	Voluntary Water Efficiency Labelling	Voluntary
6	India	Water Efficient Products-India	Voluntary
7	Malaysia	Guidelines Voluntary WEPLS	Voluntary
8	New Zealand	Water Efficiency Labelling Scheme	Mandatory
9	Portugal	National Plan for Efficient Water Use	Voluntary
10	Singapore	Water Efficiency Labelling Scheme	Mandatory
11	UAE	Emirates Authority for Standardisation and Metrology (ESMA)	Mandatory
12	United Kingdom	ECA Water Technology List	Voluntary
13	United States	WaterSense	Mandatory

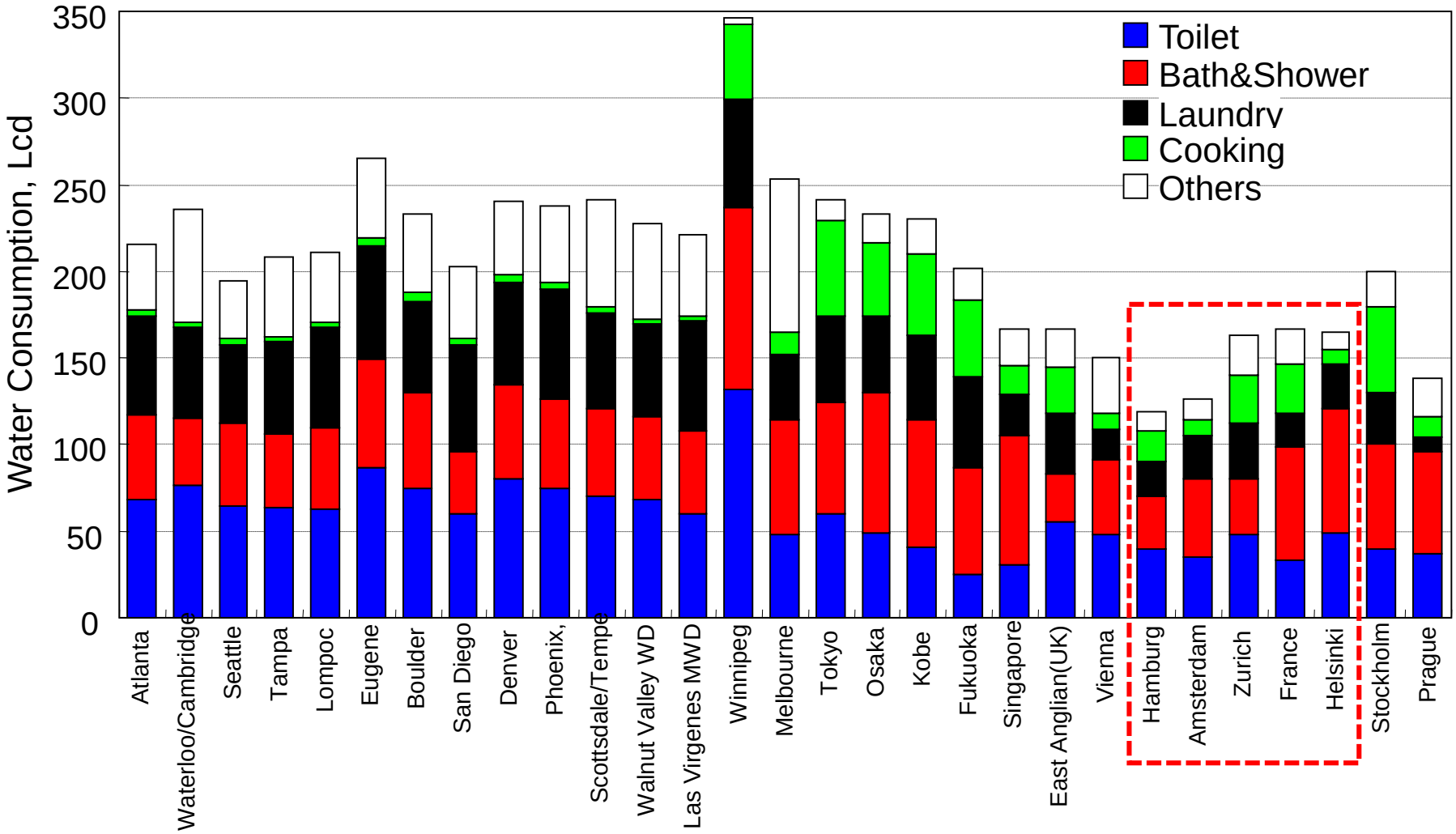
Residential Water Consumption per capita from Selected Countries in the World (l/capita.day)



(Note: Collected data ranging from 2004-2016)

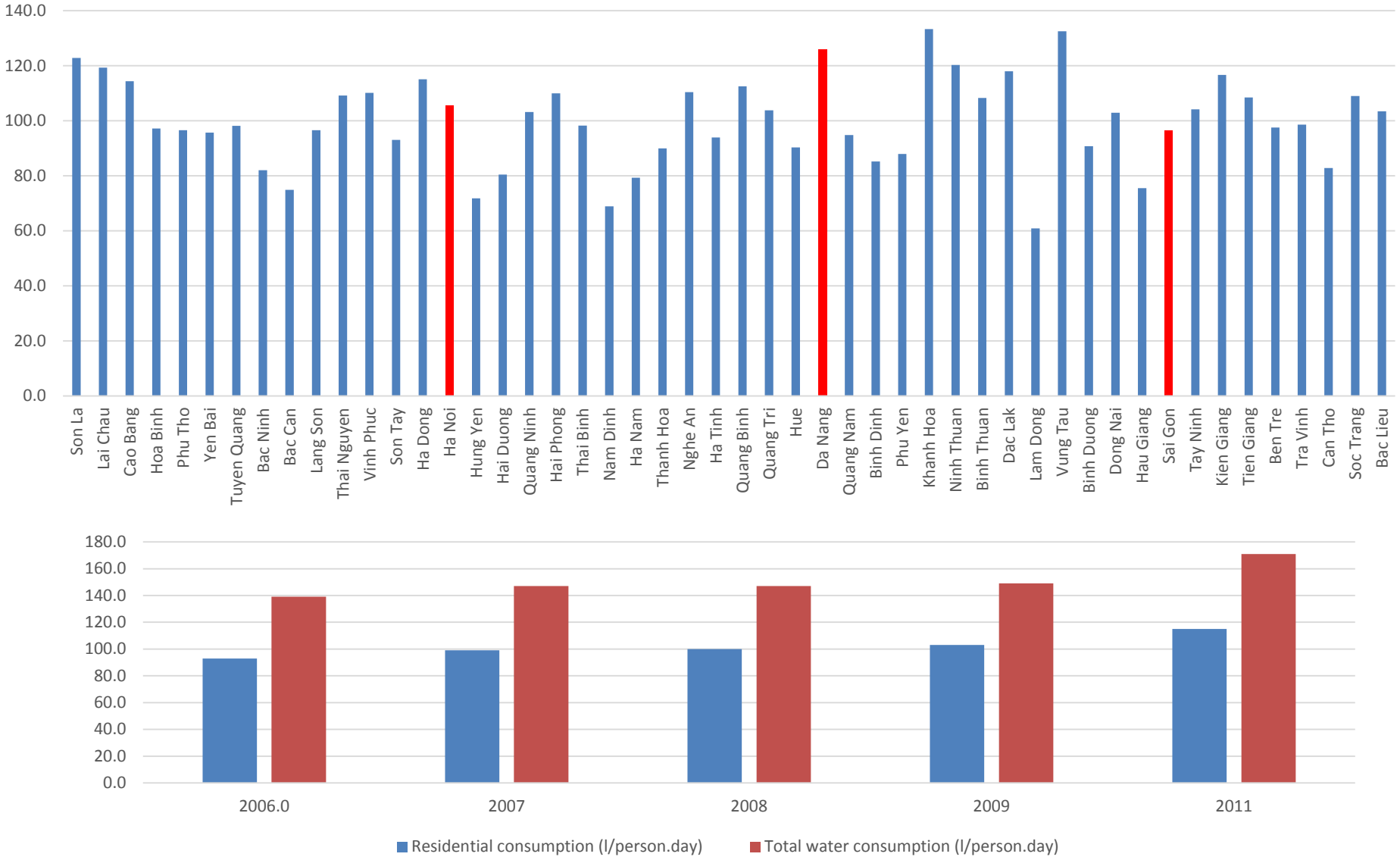
(Source: IBNET, 2017)

MICRO-COMPONENTS SURVEY ON RESIDENTIAL IN-HOUSE WATER CONSUMPTION



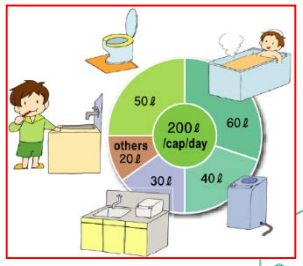
(Source: Y. Otaki et al., 2003)

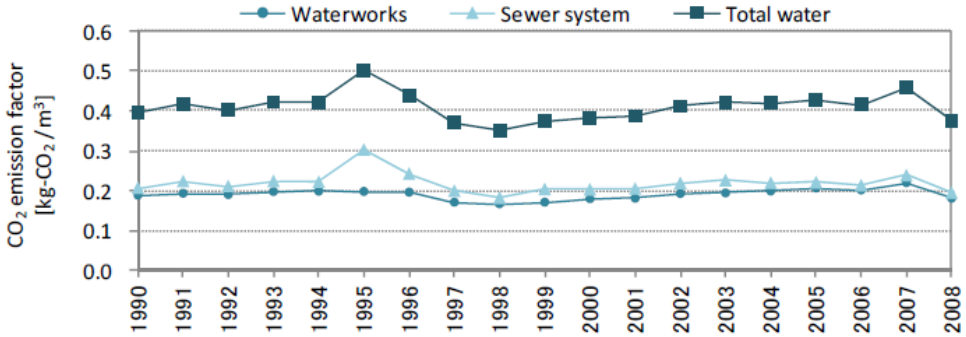
Residential Water Consumption per capita in Vietnam (l/capita.day)



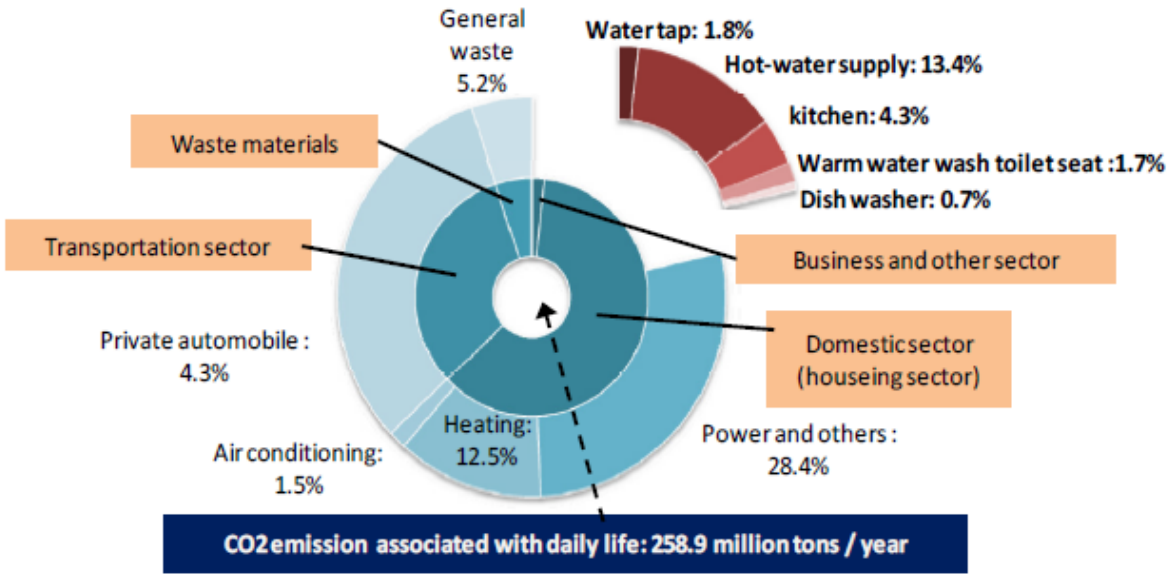
JAPAN

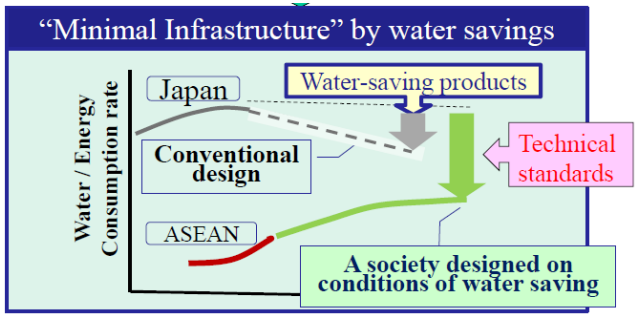
Breakdown of CO2 emissions from residential houses & water works in Japan





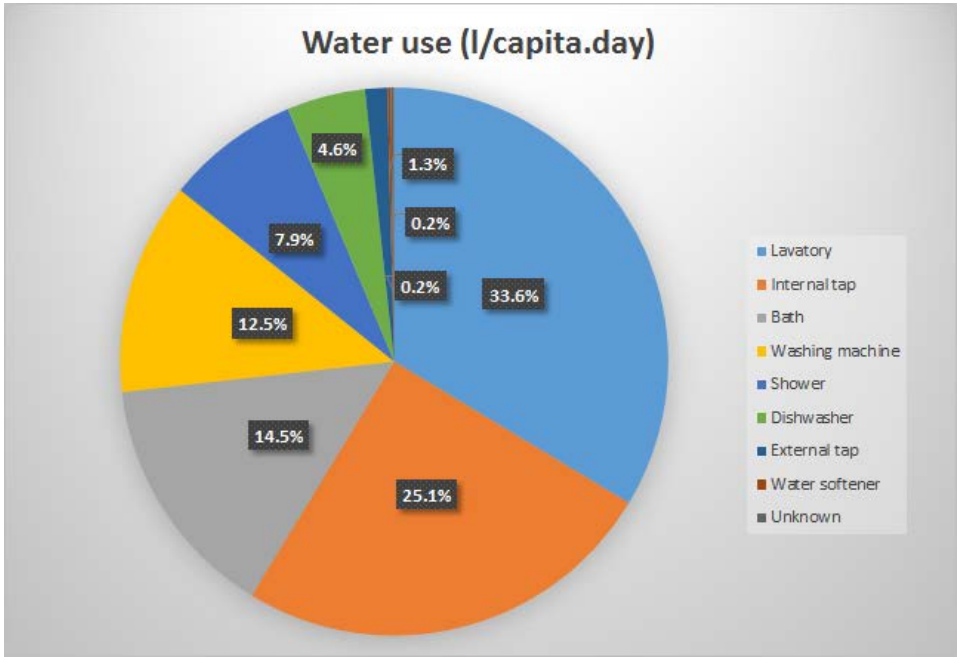
CO2 emission factor of water in Japan





(Source: Shimizu et al., 2012; Toto, 2015)

Estimation of Carbon Dioxide Emission Savings Potential of Household Water Use Reduction in the UK

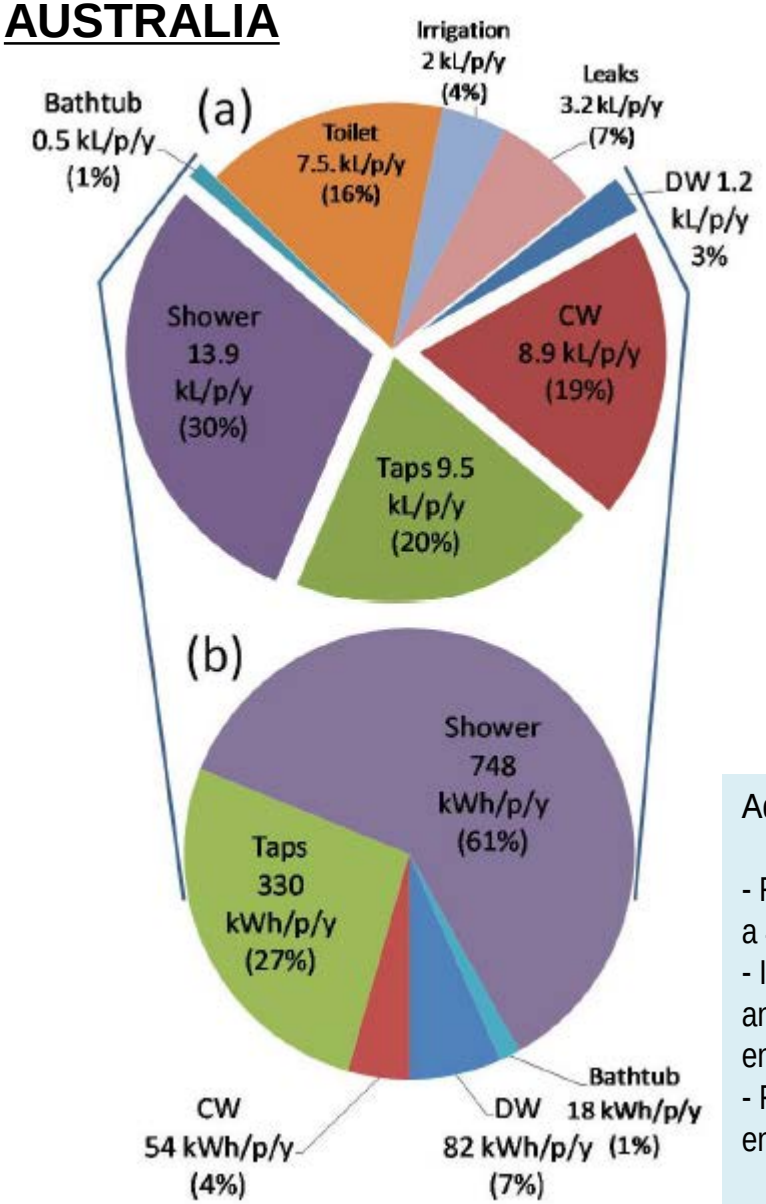


Household water use by activity, in England and Wales for 2007

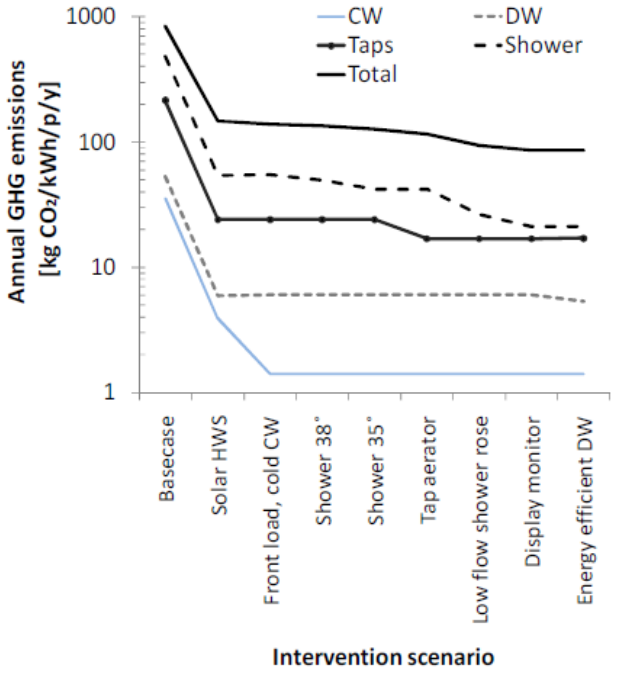
- ✓ Average UK water usage is 55,121 l/capita.year (or about 151 l/capita.day)
- ✓ The supply of this volume of water and its subsequent treatment by the water companies is equivalent to just 38.6 kg CO_2/capita.year.
- ✓ Heating water within the household using electricity requires 5,036 kWh/capita.year, equivalent to a further 2,830 t CO_2/capita.year with 57% of energy associated with use of heated tap water.
- ✓ Water efficient appliances and the careful use of heated water in the home could reduce average household water use from 151 to 73 (l/capita.day) as well as the volume of water required to be heated thereby reducing related emissions by 58% or 1,662 kg CO_2/capita.year, where electricity is used.

(Source: Hackett & Gray, 2009)

AUSTRALIA



Average annual end use breakdowns for (a) water consumption (kL/p/d) and (b) energy consumption (kWh/p/d) in **Queensland, Australia**



Impact of various energy and water efficient intervention scenarios on GHG emissions

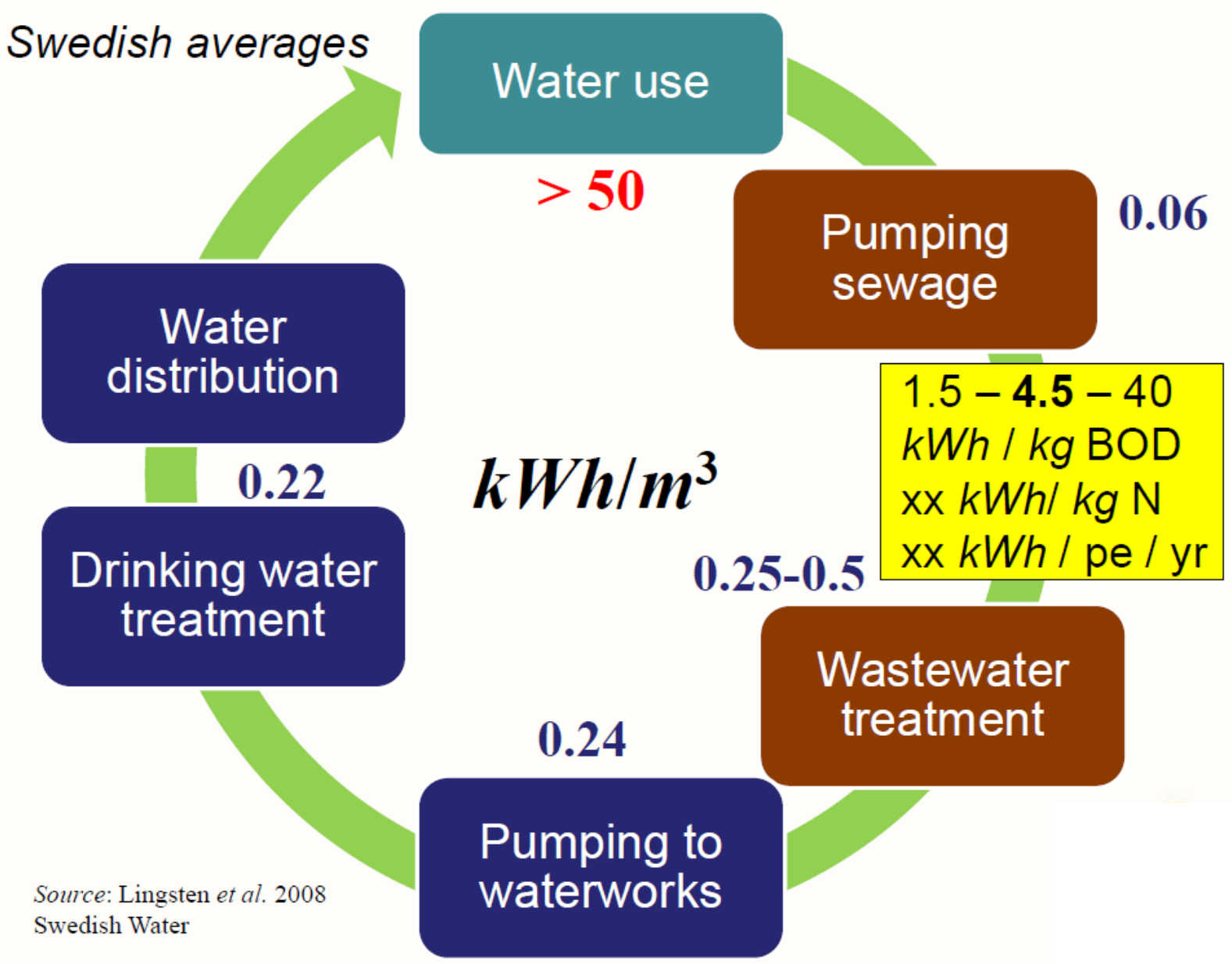
Adoption of water-efficient technologies can markedly reduce energy consumption:

- Replacing an electric hot water system with a solar hot water system can achieve around a 40% reduction in energy consumption and carbon emissions.
- Installing a low-flow shower rose can provide potential total savings of nearly 40% of annual total household water consumption and at least 60% energy savings.
- Front loading, cold tap only connected clothes washers can potentially reduce water and energy consumption by up to 30% and 90%, respectively.

Water saving behaviours, *such as having a shorter shower, should be adopted to maximise the effectiveness of water-efficient technologies. Reducing the temperature of shower hot water from 40 to 37˚ C can result in energy savings of at least 10%.*

(Source: Bertone et al., 2012; Stewart and Kenway, 2012)

SWEDEN



(Source: Olsson, 2012)

Water Conservation Strategy

Mandatory

Cut down on excessive flow and wastage of water

Voluntary

3R Approach

Promote ownership of water conservation

Pricing

Reflect the strategic importance and scarcity value of water

l/capita.day	165L	153L	147L
Year	**2003**	**2011**	**2020**

SINGAPORE

Water Efficiency Labelling Scheme

For consumers

The Water Efficiency Labelling Scheme (WELS) was launched on 31 Oct 2006 as part of the 10-Litre Challenge. It is a voluntary scheme showing how efficient fittings and appliances are.

On 1 July 2009, the Mandatory Water Efficiency Labelling Scheme (MWELS) was introduced. It is a grading system of 0/1/2/3 ticks to reflect the water efficiency of a product

The products under this scheme include:

Mandatory WELS
1) Shower Taps and Mixers
2) Basin Taps and Mixers
3) Sink/Bib Taps and Mixers
4) Dual-Flush Low Capacity Flushing Cisterns
5) Urinal flush valves and Waterless Urinals
6) Clothes Washing Machines

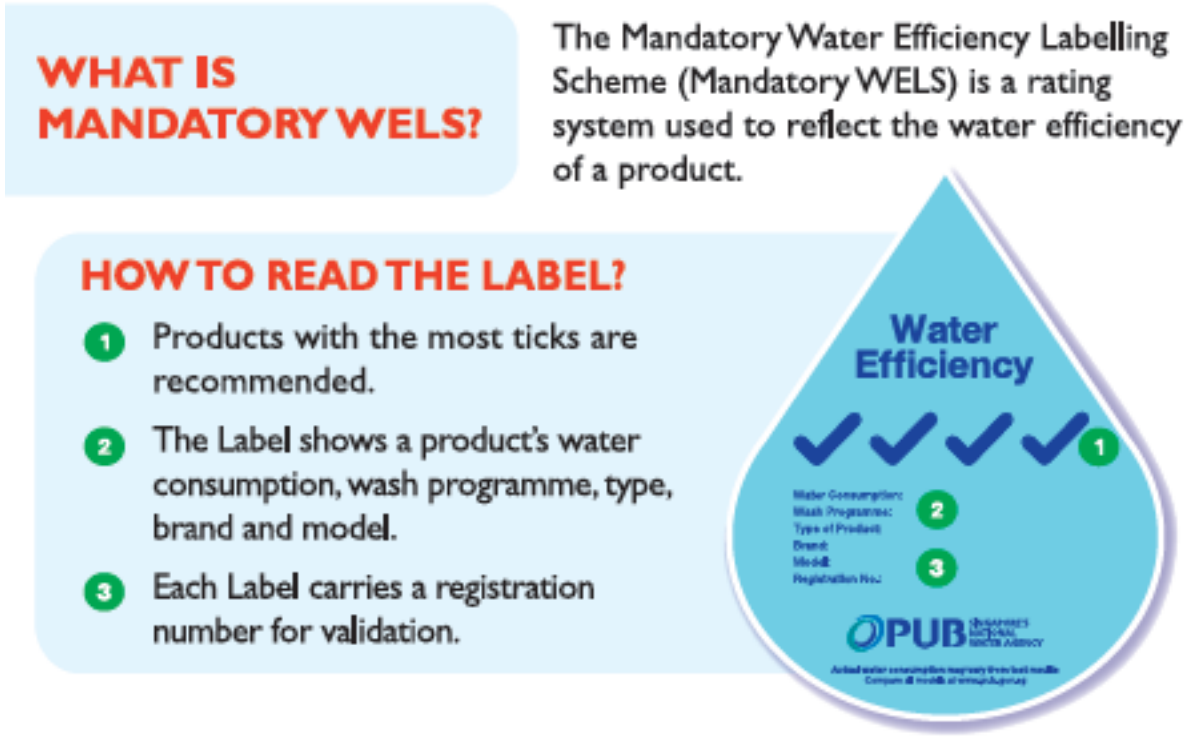
Voluntary WELS
1) Showerheads

(Source: PUB, 2017)

SINGAPORE

For Supplier/Manufacturers

It is mandatory for all importers, parallel importers, retailers, manufacturers, suppliers and distributors, of water fittings/appliances to register their products under the Water Efficient Labelling Scheme.



(Source: PUB, 2017)

	Products/Fittings	Flowrate / Flush Capacity Requirements		
		1-Tick	2-Tick	3-Tick
	Under Mandatory WELS			
1	Shower Taps & Mixer 	> 7 to 9 litres/min	> 5 to 7 litres/min	5 litres/min or less
	Savings	11%	33%	44%
2	Basin Taps & Mixers 	> 4 to 6 litres/min	> 2 to 4 litres/min	2 litres/min or less
	Savings	17%	50%	67%
3	Sink/Bib Taps & Mixers 	> 6 to 8 litres/min	> 4 to 6 litres/min	4 litres/min or less
	Savings	13%	38%	50%
4	Flushing Cisterns ** ++ (Per Flush) 	Dual Flush > 4 to 4.5 litres (full flush) > 2.5 to 3 litres (reduce flush)	Dual Flush > 3.5 to 4.0 litres (full flush) > 2.5 to 3 litres (reduce flush)	Dual Flush 3.5 litres or less(++) (full flush) 2.5 litres or less (reduce flush)
	Savings	NA	12%	18%
5	Urinal Flush Valve & Waterless Urinals (Per Flush) 	> 1 to 1.5 litres	> 0.5 to 1 litres	0.5 litres or less(**) or waterless urinals
	Savings	NA	40%	60%

	Under Mandatory WELS				
		Wash Volume			
		1-Tick	2-Tick	3-Tick	4-Tick
6	Clothes Washing Machines (Per Wash load) 	NA	> 9 to 12 litres/kg	> 9 to 6 litres/kg	6 litres/Kg or less
	Savings	NA	NA	29%	43%

	Under Voluntary WELS			
	Products/Fittings	1-Tick	2-Tick	3-Tick
7	Showerheads 	> 7 to 9 litres/min	> 5 to 7 litres/min	5 litres/min or less
	Savings	11%	33%	44%

(Source: PUB, 2017)

5 tips to SAVE ≈ 140 litres a day

Showers
SAVE 45 litres
- ✗ 10-min shower 90ℓ
- ✓ 5-min shower 45ℓ

Brushing your teeth
SAVE 11.5 litres
- ✗ Tap running for 2 minutes 12ℓ
- ✓ Using a mug 0.5ℓ

Flushing the toilet
SAVE 3 litres
- ✗ 4 full flushes per day 18ℓ
- ✓ 2 full flushes, 2 half flushes 15ℓ

Dish washing
SAVE 28 litres
- ✗ Washing under a running tap for 5 minutes 40ℓ
- ✓ Filled sink/container 12ℓ

Washing machine
SAVE 52.5 litres
- ✓✓✓✓ 4 ticks

Source: Water Conservation Awareness Programme (PUB)
www.pub.gov.sg

YOU CAN PLAY YOUR PART IN SAVING WATER WITH THESE SIMPLE TIPS

Monitor your water bills
Check your water bill to monitor your family's water consumption. If your consumption is more than the average, re-look your family water usage habits.

Take shorter showers
Keep showers to under 5 minutes and turn off the tap while soaping.

Wash in a filled sink
Wash vegetables and dishes in a filled sink instead of under a running tap.

Wash on a full load
Fill your washing machine on a full load.

Reduced flush
Use reduced flush for liquid waste.

Repair leaks promptly
Repair leaks and dripping taps immediately to prevent water wastage.

Reuse
Collect rinse water from the washing machine for flushing the toilet or mopping the floor.

START WITH THE LITTLE THINGS
Small changes in your daily routine can help save 10 litres of water a day.

10 LITRES
is approximately seven 1.5-litre bottles.

SAVING WATER IS EASY
SAVE 45 litres — Showers
- ✗ 10-min shower 90ℓ
- ✓ 5-min shower 45ℓ

SAVE 28 litres — Dish washing
- ✗ Washing under a running tap for 5 minutes 40ℓ
- ✓ Filled sink 12ℓ

PUB SINGAPORE'S NATIONAL WATER AGENCY
Tel: 1800-2255-782 (CALL-PUB)
www.pub.gov.sg

GOOD WATER SAVING HABITS

(Source: PUB, 2017)

MALAYSIA

5 Key Strategies for Sustainable Water Supply Towards 2050

DEMAND Management	SUPPLY Management
1. Public Education & Awareness ▪ Alert public on water issues ▪ Cultivate water saving society ▪ Promote sustainable development ▪ Focus on primary and secondary students 2. Raise the Value of Water ▪ Tariffs and Water Consumption Surcharge to reduce consumption ▪ ''More you use, more you pay'' 3. WSDs: Water Saving Devices ▪ Building by-law: mandatory for new projects ▪ Incentives for retro-fitting in existing buildings	4. Holistic Water Supply Management ▪ Protect water catchments ▪ Manage NRW ▪ Upgrade water supply infrastructure to mitigate higher risks due to climate change 5. Additional Raw Water Resources ▪ Surface water ▪ Rainwater harvesting ▪ Water recycling ▪ Desalination

(Source: Ujang, 2017)

WATER SAVING TIPS IN MALAYSIA

Water Saving Tips Outdoor (LWAN)

✓ Use a garden watering can or a bucket to water your lawn or garden instead of a hose.

✓ Use a bucket to wash your car and avoid using a hose.

✓ Avoid using a mist fan for cooling as it consumes a lot of water if used over a period of time.

✓ Consider replacing some turf area with low water use plants and ornamental grass. They are easier to maintain than turf, looks beautiful, and require far less water.

✓ Group plants based on its watering needs. Creating “watering zones” in your garden will allow you to give each plant the water it requires — not too much or too little.

✓ Water the lawn or your plants early morning or late evening to avoid water loss through evaporation from the heat.

✓ Water your lawn only when it really needs it.

✓ Use a broom not a hose to clean the driveways and sidewalks.

Water Saving Tips At Home (KITCHEN)

✓ Minimize use of kitchen sink garbage disposal units as it requires a lot of water to operate properly.

✓ Think ahead! Don’t use water to defrost frozen foods, instead leave them in the

✓ Wash vegetables, fruits or food in the sink filled with water instead of running w

✓ Install a low-flow faucet aerator, which can cut water use in half. Water saved: 4

Water Efficiency Label

Water Consumption *nominal flow rates* (*f*) (l/min)	Water Efficiency Grade	Rating	Symbol on Label
6.0 < *f* ≤ 8.0	Efficient	1★	★
4.0 < *f* ≤ 6.0	Sink Taps and Mixers		★★
2.5 < *f* ≤ 4.0	Most Efficient	3★	★★★

(Source: SPAN, 2017)

WATER SAVING TIPS IN MALAYSIA

Water Saving Tips At Home (BATHROOM)

- ✓ Take shorter showers of 5 minutes per day as it could save up to 400 litres in a week.
- ✓ Don't let the water run while washing your face, shaving or brushing
- ✓ Turn off the shower while lathering or shampooing.
- ✓ Install water efficient taps, water closets and shower heads.

Water Saving Tips At Home (LAUNDRY)

- ✓ Use a front-loading washing machine compared to a top loading washing machine because it can save water and energy.
- ✓ Use the washing machine only with a full load to save water.
- ✓ Consider purchasing a water-saving washing machine model the next time you buy a new washing machine as it can save 40 to 65 litres per load.

Water Saving Tips At Home (TOILET)

- ✓ Replace single flush with dual flush mechanism because it can save 3 to 6 litres of water per flush.
- ✓ Perform regular inspections to identify leaks as toilet leaks can waste up to 100,000 litres of water in a year.
- ✓ Check for toilet tank leaks by adding food colouring to the tank. If the colour shows up in the bowl without flushing, it's confirmed there's a leak.
- ✓ Don't use the toilet as an ashtray or wastebasket. Every time you flush a cigarette butt, facial tissue or other small bits of trash, 3 to 6 litres of water is wasted.

Water Efficiency Label

Water Consumption *nominal flow rates (f)* (l/min)	Water Efficiency Grade	Rating	Symbol on Label
$8.0 < f \leq 10.0$	Efficient	1★	★
$6.0 < f \leq 8.0$	Highly Efficient	2★	★★
$4.5 < f \leq 6.0$	Most Efficient	3★	★★★

Shower Taps or Showerhead

Water Consumption *Volume per wash load v (litre/kg)*	Water Efficiency Grade	Rating	Symbol on Label
$12 < v \leq 15$	Efficient	1★	★
$9 < v \leq 12$	Highly Efficient	2★	★★
$v \leq 9$	Most Efficient	3★	★★★

Washing Machine

Water Consumption *Flush volume per flush (fv)* (litre/flush)	Water Efficiency Grade	Rating	Symbol on Label
Full Flush $fv \leq 6.0$ Reduced Flush $fv \leq 3.0$	Efficient	1★	★
Full Flush $fv \leq 5.0$ Reduced Flush $fv \leq 3.0$	Highly Efficient	2★	★★
Full Flush $fv \leq 4.0$ Reduced Flush $fv \leq 3.0$	Most Efficient	3★	★★★

Water Closet

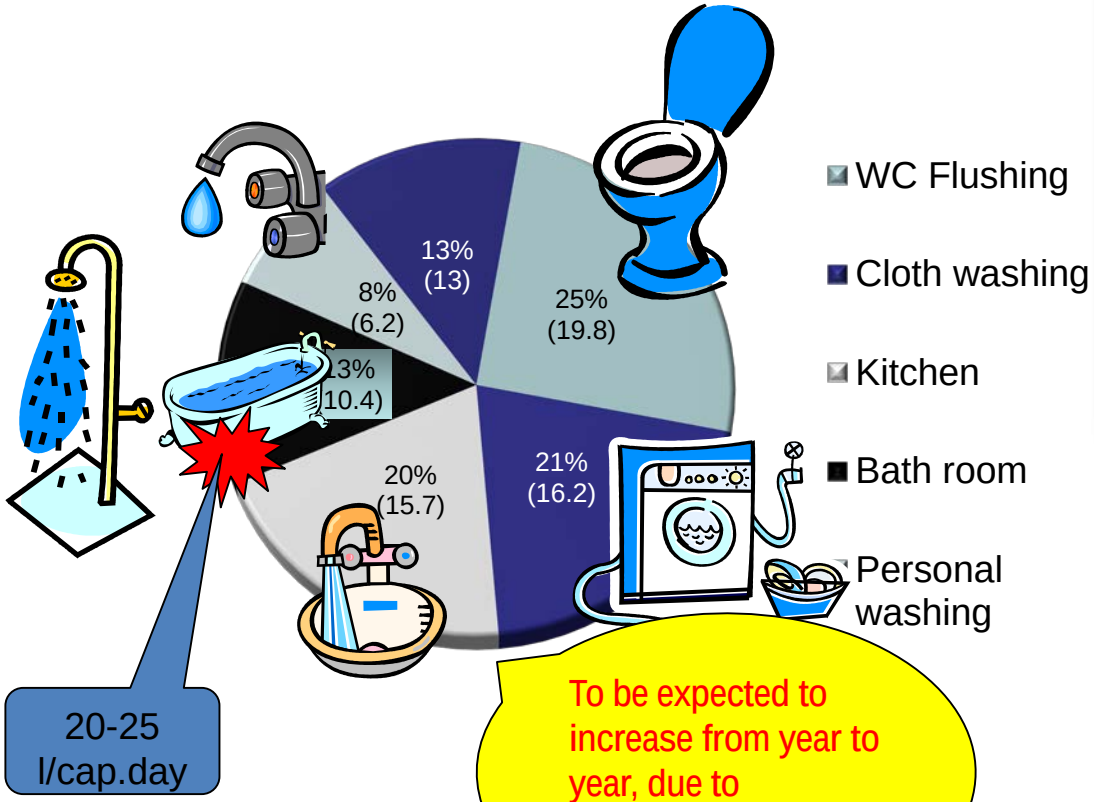
Water Consumption *Flush volume per flush (fv)* (litre/flush)	Water Efficiency Grade	Rating	Symbol on Label
$1.5 < fv \leq 2.5$	Efficient	1★	★
$1.0 < fv \leq 1.5$	Highly Efficient	2★	★★
$fv \leq 1.0$	Most Efficient	3★	★★★

Urinal equipment

(Source: SPAN, 2017)

VIETNAM

Residential Indoor Uses of Water in Hanoi



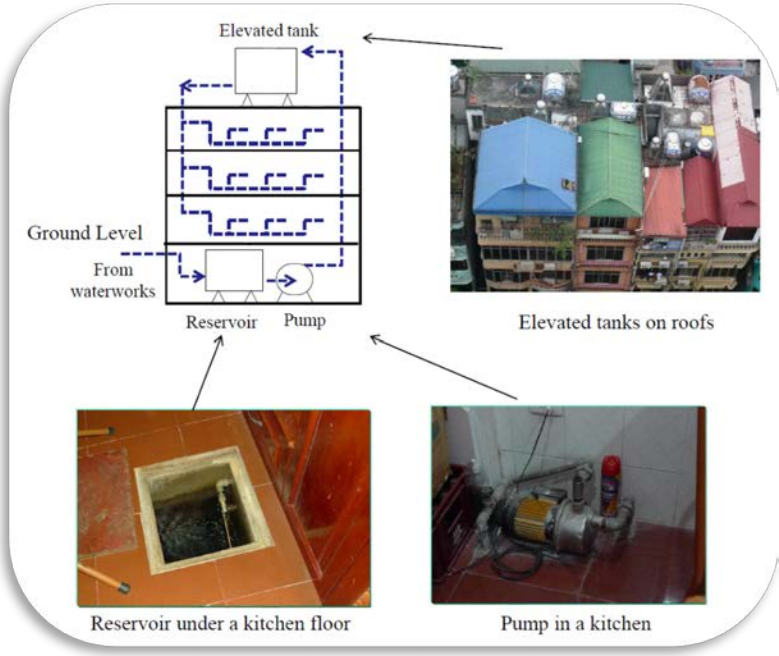
20-25 l/cap.day

Total amount of water use per capita ranges 90-95 l/cap.day, (including some uncertainty)

To be expected to increase from year to year, due to improved living standard

Almost the same as case in Chiang Mai

(Source: Bao et al., 2013)



Indoor water supply system in Vietnam

Process	Emission Factor (kg-CO_2/m^3)
Waterworks system	0.23
Sewer system	0.16
Water supply system in a house	0.32

Note: CO_2 emission factor of electricity: 0.576 kg-CO_2/kw·h.

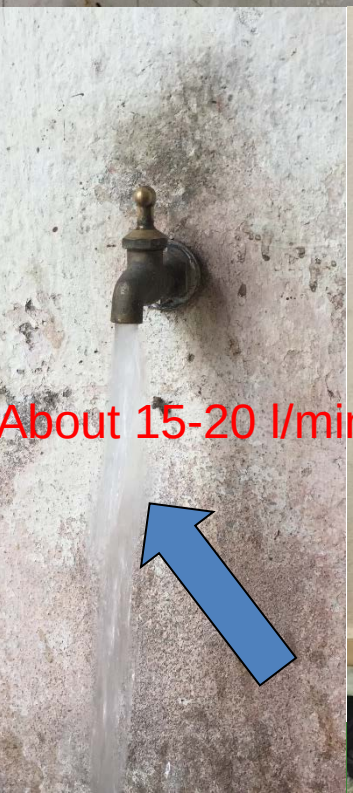
CO2 emission factor of water in Vietnam

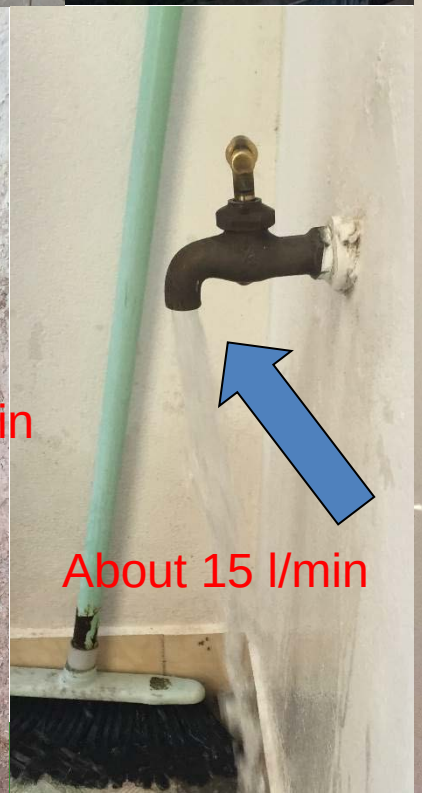
→ The annual electricity consumption per capita in Vietnam is around 872 kWh, and energy consumption by water pumps accounts for about 3%.

(Source: Otani et al., 2015)

DA NANG


About 6 l/min


About 15-20 l/min


About 15 l/min


About 7-15 l/min
About 1.5-2 l/min
About 6 l/min
About 6 l/flush
About 6l/min

Available Water-Saving Appliances in Markets

Box 1. Examples of water-saving shower heads and faucet aerator water saving device

Efficient shower heads operate by mixing water flow with an air jet. Whereas a **five-minute** shower with a normal shower head can use up **to 50-100 liters of water**, a water efficient shower head consumes a modest **35 liters**.

Meanwhile, many available faucet aerator water saving device on the market can **save up to 50% of water use**

Roughly Estimation of Residential Water-Energy Saving Potential in Da Nang

Population	125 (l/capita.day)	100 (l/capita.day)	Water Saving Potential (m3/day)	Energy saving potential (kWh/day)	GHG emission reduction potential (kg CO2/day)
1 million	125,000 (m3/day)	100,000 (m3/day)	25,000	29,427	16,950
1.2 million	150,000 (m3/day)	120,000 (m3/day)	30,000	35,313	20,340
1.4 million	175,000 (m3/day)	140,000 (m3/day)	35,000	41,198	23,730
1.6 million (2020)	200,000 (m3/day)	160,000 (m3/day)	40,000	47,083	27,120
1.8 million	225,000 (m3/day)	180,000 (m3/day)	45,000	52,969	30,510
2.0 million	**250,000 (m3/day)**	200,000 (m3/day)	50,000	58,854	33,900
2.2 million	275,000(m3/day)	220,000 (m3/day)	55,000	64,740	37,290
2.4 million	300,000 (m3/day)	240,000 (m3/day)	60,000	70,625	40,680
2.5 million (2030)	312,500 (m3/day)	**250,000 (m3/day)**	62,500	73,568	42,375

ADDRESSING THE CRITICAL QUESTIONS BEFORE ACTIONS

- ✓ Why GHG emission reduction is necessary?
- ✓ Is there any interlinkage between lifestyles CHANGE, and water-energy saving practices, as well as GHG emission reduction?

1. Must we change? "YES"

2. Can we change? "YES"

3. Will we change?

3. Will we change?

Thank you very much for your attention.

For further information, please contact:

Pham Ngoc Bao, Ph.D
Senior Water and Sanitation Specialist
Institute for Global Environmental Strategies (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa 240-0115 Japan
TEL : + 81-46-855-3880 (ext.3093)
E-mail : ngoc-bao@iges.or.jp